Evacuation Traces Mini Challenge Award: Innovative Trace Visualization Staining for Information Discovery

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ABSTRACT

Staining is a technique for categorizing time-varying spatial data; that is, data of things moving through space over time. In Staining, a stain is applied in either time or space, and the objects which move through the stain become marked. This technique and a research prototype demonstrating the technique were developed in response to the VAST 2008 Contest Mini-challenge: Evacuation Traces.

KEYWORDS: Movement data, visual analytics, exploratory data analysis, visualization, interactive displays.

INDEX TERMS: H.5.2. [User Interfaces]: Graphical User Interfaces

1   INTRODUCTION

In this paper, we present a new technique for analysis of time varying spatial data. We call this approach "staining". The example data used in this presentation is that of the VAST 2008 Mini-Challenge: "Evacuation Traces" [1]. The Evacuation Traces data is fictitious data representing the positions of people in a building during a time before and after an explosion. The challenge of the data is to determine as much information about the explosion as possible from the positions of the people during that time.

For the example application, the spatial data is represented on a map of the building. As shown in Figure 1, the people are represented by circles and the walls of the building are black. The application begins with the spatial data represented at the initial time point in the data and no stains in place. The analyst can apply a stain in time or space, or just animate the data.

2   STAINING

The staining technique provides a mechanism of data analysis by allowing the analyst to place stains in time and space. As the people move through these stains, they become stained. The analyst can then change the time viewed while the stains remain in place. This allows the analyst to move people to their position at the beginning time in the data while they are stained according to their ending locations.

2.1   Spatial Staining

To apply a stain in space, the analyst selects a color and a brush, and applies the stain to the map. As people encounter the stain they are added to the "Stained People" list, shown to the right of the map in the application window. These people are also marked

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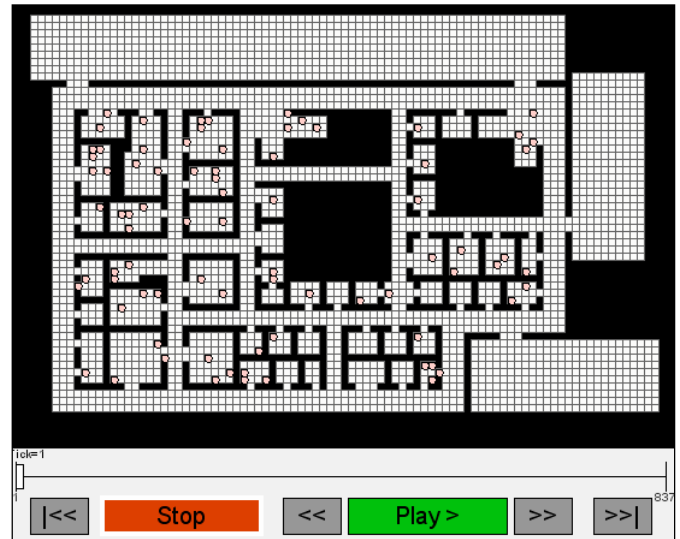*djb@acm.org
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Figure 1: The map portion of the application showing people in their initial locations.

with the stain color in the spatial representation. As shown in Figure 2, the analyst has applied a stain to a portion of the map and during the course of the animation; five people have encountered that stain and are listed to the right of the map (below the "staining tools").
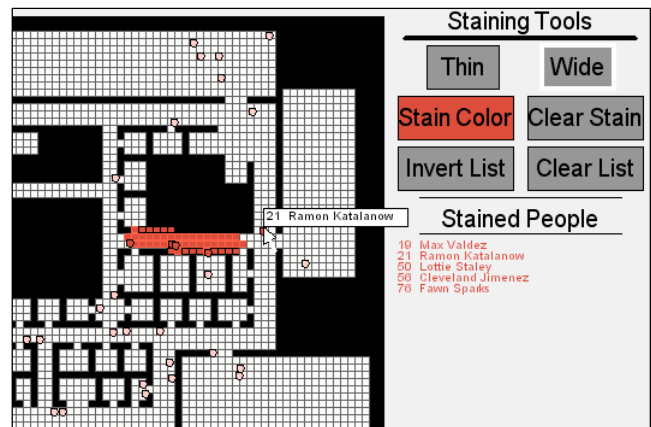

Figure 2. The building map with a red stain (gray area) applied in the middle of the map shown and a list of people who have encountered the stain, including those who have left the stain area; for example: 21. Ramon Katalanow, whose position on the map is indicated by the hovering mouse pointer.

Spatial stains can be added to, or removed from, the map at any point in the time animation. Stains of the same color can be

applied to the map in different locations. Also, stains of different colors can be added to the map simultaneously.

The stained list can be inverted. In this case, those people stained are removed from the list and those not stained are added to the list. In this way, the analyst can easily determine who did not visit a particular place.

2.2   Temporal Staining

Staining in time is similar to staining in space in that the analyst applies the stain and the objects that move (in this case: people) become stained automatically. Staining in time is different in that the time stain is applied immediately based on whether or not an object/person moved between the stained time interval.

To apply a stain in the time domain, the analyst selects an interval of time from the time bar in the application by dragging the pointer on the time line. As shown in Figure 3, the selected time interval becomes highlighted and the people who move
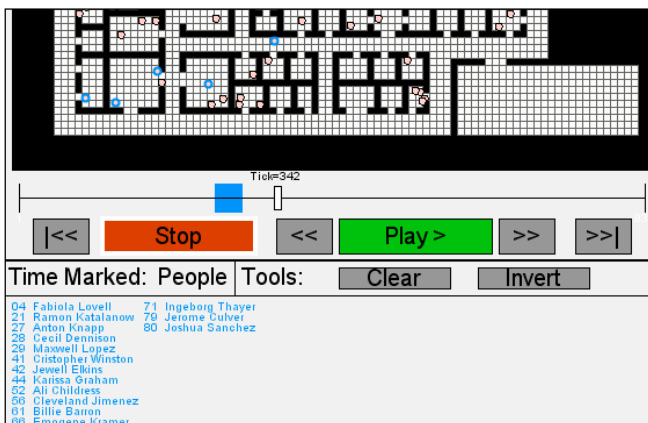
during that time interval become stained with the time-stain color.

Figure 3: A time interval selected for time staining (shaded area on the time line) and the list of people who move during that interval (partial map shown). Those who have moved are listed (at the bottom) and highlighted on the map.

As with the spatial staining, the time stain list can be inverted, giving the analyst an easy way to determine people who did not move during some time interval.

3   DISCUSSION

The staining technique and research prototype application proved useful in answering the questions of the VAST 2008 Evacuation Traces Mini-Challenge. An analyst experienced with the tool is able to complete the four tasks of the challenge with the tool in less than two minutes.

3.1   Staining in the VAST 2008 Contest Evacuation Traces Mini-Challenge Tasks

The following subsections discuss the application of the staining technique to the four tasks of the VAST 2008 Contest Evacuation Traces Mini-Challenge.

3.1.1   Where was the device set-off?

The device location is found by manipulating the time and observing the movement of people. Initially, there are between five and 15 of the 81 people in motion at some reasonable interval of time. At a particular time, nearly everyone is in motion and most are heading for an exit. Shortly after most people are moving, there are some people who stop. It is suspected that this would be near the blast site.

It is easy to determine who has visited this site by staining the general location and then animating. Appling the stain at the beginning of the time data and removing it at the blast time will stain only those people who travelled to the area of interest during the time before the blast.

This technique identifies a small number of people. Only one of these people survive the blast and exhibits suspicious behavior by leaving the area, then returning to it, before exiting the building. The path of this suspicious person leads us to believe we have found the location for the device.

3.1.2   Identify potential suspects or witnesses.

Using the same technique as above, it is easy to stain those people in the area of the blast before the blast occurs. This list of people is the list of suspects and witnesses.

3.1.3   Identify any suspects or witnesses who manage to escape the building.

Again, using the same staining technique above, a list of suspects and witnesses is found. After creating this list, the analyst simply advances the animation to the end of the time and finds that only one person on the witnesses and suspects list manages to escape the building

3.1.4   Identify any causalities.

For this task, we assume that people who do not exit the building are casualties. To identify this list of people, the analyst places stains at each of the exits. Then as the analyst allows the animation to play from beginning to end, each person who exits the building is stained. Inverting this list creates a list of people who did not exit the building

3.2   Staining in General

The staining technique is not only useful in the analysis of evacuation data and could be used to analyze time-varying spatial data from other problem domains. In particular, the staining technique is useful when the questions are about who, or what, has been in a particular location at a particular time.

4   CONCLUSION

The technique of staining for the analysis of time-varying spatial data is presented. The technique was successfully employed for the analysis of the Evacuation Traces Mini-Challenge of the VAST 2008 Contest.

The staining technique was found useful to addressing the tasks of the VAST Contest. It is also thought that the technique would be useful to other time-varying data where comparable analysis questions are asked.

REFERENCES

[1] Plaisant, C., Grinstein, G., Scholtz, J., Whiting, M., O'Connell, T., Laskowski, S., Chien, L., Tat, A., Wright, W., Gorg, C., Liu, Z., Parekh, N., Singhal, K., Stasko, J. Evaluating Visual Analytics: The 2007 Visual Analytics Science and Technology Symposium Contest, *IEEE Computer Graphics and Applications*, 28, 2, 12-21 (2008).